perhaps only to Utricularia. Their flowers are delightful, and when the species discussed here reach flowering size they continually produce scapes all year. And the plants are easy! If you can grow terrestrial Utricularia then you can grow the plants I described here. I have never grown an aquatic Genlisea, and anticipate they may be more exacting in their treatment (as is the case with most aquatic Utricularia). Very recently I have obtained specimens of *G. repens* and a plant which may be *G. pygmaea*. Time will tell how much luck I have with them. Good luck with yours!

Figure 1: Flower of *G. hispidula*

Figure 2: Flower of *G. violacea*

# Growing Carnivorous Plants in a Semi-Arid Climate

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I live in Southern California approximately 100 miles (160 KM) east-southeast and inland from the City of Los Angeles. Although this area is not classified as a desert, it has the feel of one in the summer: it is hot and very dry. Technically, with 13 inches of annual precipitation (33 cm) the climate is considered semiarid and is classified as a Mediterranean, dry-summer type; almost all the annual rainfall occurs in the winter months. The daytime high temperatures in July and August average over 100 °F (37.8°C). Maximum temperatures can exceed 110 °F (43.3°C). Rainfall during the summer months is almost nonexistent. The elevation here is 1517 feet above mean sea level (462 meters). Because of the hot, dry air and relentless sun, the climate is very hostile to tender, water-loving plants. In spite of the climatic difficulties I have been growing carnivorous plants (CP) outdoors for the last 15 years. Several of my Sarracenias were obtained as two-year old plants in 1976 and are still flourishing. None of the plants are grown in any kind of shelter; all are grown in pots standing in the direct sun.

I had always read that CP required very high humidity to survive. When I first started growing CP in Southern California I attempted many different methods of maintaining high humidity in and around the plants: I grew some indoors under lights; I grew some outdoors in terrariums and other contraptions designed to retain high relative humidity. The indoor experiments resulted in limited success. The plants would flourish and grow with great vigor for a year or two, then would slowly decline.

After a while I realized that the plants required a dormancy period in the winter that I was having difficulty providing with indoor growing conditions. The outdoor plants in various forms of terrariums did not fare as well. Generally, if the outdoor terrarium plants received enough sunlight to match their needs, they could not survive the high temperatures resulting from semi-enclosure in glass or plastic cases. If the plants were placed in locations where the sun did not burn them, they didn't receive enough light for health and vigorous growth.

The solution was to attempt to grow them as 'normal', potted plants. All the plants were placed in one gallon or larger, plastic pots in a mix of peat moss and sand, and placed in deep saucers. Most of the plants seem to do well for me in a mix of two parts peat moss to one part sand. In the past all watering was by top watering with sufficient quantity to cause the saucers to overflow. When the saucers dried out completely, the plants would be watered again. Because of the five year drought in Southern California I have switched to using seven-inch deep trays that hold five or six pots each to prevent water loss by overflow. An additional benefit is that the plants need to be watered less frequently than they did with shallow saucers. However, an unforeseen benefit is that they appear to grow much better with the deep tray watering system.

Many plants grown using this method in this climate are large and robust, though not as robust as they would be if grown in their native habitat. Some Sarracenias grow so quickly that they can overwhelm a one gallon pot in about two years. One example is a red-tube variety of *Sarracenia flava* that has been growing in a two gallon pot for just over two years. It was planted as a mature rhizome acquired from World Insectivorous Plants. At the time the rhizome only had a single growth crown. It now has multiple growth crowns and is deforming the pot in which it is planted.

One possible aid to plant growth is the proximity of several dairy farms and the hoards of flying insects they support. The quantity of insects that the upright Sarracenias and large Droseras capture over the summer is surprising. In addition to the abundant insects available to the plants they seem to create their own microclimate and microecological system. Many predatory insects, spiders, and several frogs have taken up residence in and around the pots. Small spiders weave webs at the mouths of Sarracenia leaves; praying mantises and jumping spiders sit near the tops of the leaves in a head-down attitude awaiting the arrival of new prey; frogs usually sit on the soil in the pots but occasionally will sit on a leaf like a praying mantis; and black widow spiders try to occupy the areas between the pots. I try to discourage the presence of the black widows.

While the Sarracenias are prolific and grow very well, the maximum leaf height for the upright Sarracenias is only about 20 to 24 inches, which is substantially smaller than those growing wild in the Gulf Coast States. Having a growth pattern that keeps their leaves close to the ground, *Sarracenia purpurea venosa* seems less affected by the heat and grows very large in this semiarid climate. While many CP from temperate climates do well here, the carnivorous plants that seem to thrive in this climate tend to be Australian varieties such as *Drosera binata, Drosera burmanni*, and *Byblis liniflora*. In particular, the Byblis only truly thrives during the dog days of August when it overwhelms any pots in which it is growing.

From December into February the night temperatures are usually at or below freezing and may dip as low as 15 °F (-9°C). This has proven adequate to initiate the dormancy period required by many carnivorous plants. In fact, the colder the winters the better most of the Sarracenias blossom in the spring.

Using information I had obtained from reading articles about carnivorous plants I attempted to provide the environment that I thought they required. After many failures I discovered that I could not provide adequate lighting and appropriate, seasonal environmental changes needed to keep carnivorous plants happy and healthy while maintaining the artificially high humidity that I believed these plants needed. It wasn't until I placed them outdoors as more common potted plants, and ignored the supposed humidity requirements that I started to have success in growing and reproducing them. I found that even the more delicate Droseras tend to grow well outdoors in spite of the summer heat as long as sufficient water is provided at all times. While partial shading appears to be beneficial to some species, most appear to thrive without any protection from the sun, even in a location where the sun is intense and clouds are few. Despite what many earlier authors on the subject of carnivorous plant cultivation may contend the need to provide artificially high humidity for many common species seems to have been overemphasized. If the other requirements of light, water, soil, and dormancy cycles are observed, the humidity question seems to fade away, at least in the hot, semiarid environment of inland Southern California.

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# Are Genlisea traps active? A Crude Calculation

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I find the structure of the Genlisea trap very interesting, although they are not well understood in the botanical literature. Many questions remain unanswered. Are prey attracted or do they just wander into the traps? How is the prey retained in the utricle (the trap's digestive chamber) and how is it digested? How are the digested nutrients retained and then assimilated? With more time and research, these questions will be answered.

The form of Genlisea traps is well known, and I described some of its features in the previous article. In this article I concentrate on a single aspect of the Genlisea trap, an aspect that would seem to be a flaw in the trap's construction. An observation has been made by Juniper, Robins, and Joel in the book, *The Carnivorous Plants* (hereafter JRJ), which may point to the plant's solution to this flaw—namely that the trap is actually active. To complete my conjectures, I present an approximate calculation exploring whether this is plausible.

It seems CP are fairly efficient digestion mechanisms. Dionaea traps allow prey to escape if the prey are too small to be worth digesting. JRJ report that *Drosera erythrorhiza* absorb a full 76% of the available nitrogen in insect prey. Yet consider the fate of a rotifer (to choose a likely nutrient source) swimming along the interior of a *Genlisea* trap. Because of strategically located trap hairs it can only swim towards the utricle where it dies and is broken down for absorption. But what of the chemicals released by the dissolving rotifer, before they are absorbed by the plant? There are no one-way valves at the entrance of the utricle (as there are in Utricularia bladders), and inward pointing hairs have no effect on individual molecules. So what prevents a significant portion of the valuable nutrients from diffusing through the utricle entrance, out of the trap, and away from the plant?

How does Genlisea prevent a wasteful loss of nutrients from the trap? Or does it simply operate inefficiently? JRJ make an observation which may be important (pg. 126). They note that utricles contain not only the digested carcasses of prey, but also particles of dirt. The traps of Genlisea hang downward, so it is difficult to explain how sinking or drifting dirt particles could find their ways into the utricle. After settling into the spiral trap entrance, the particles would need to inexplicably rise into the trap mouth, through the trap tube, and into the utricle. Instead of that unlikely scenario, is it possible these bits of detritus have been sucked into the trap by the plant's effort? Perhaps the plant is expelling water from the trap through the utricle walls. New water from outside the trap would flow up the trap tube to replace the water removed from the utricle. The expulsion would be comparable to the phase in which water is removed from the interior of a sprung Utricularia bladder and is excreted into its surroundings. This is not too implausible since the two genera are closely related and the traps of both genera contain similar internal and external glands. The purpose of this expulsion might be to suck valuable nutrients into the cell walls, and thus prevent their escape from the trap. Genlisea traps may be active and not passive.

I decided to make a few simple calculations to see if it is even wildly possible that a *Genlisea* trap could function as a pump. Could it remove water from its utricle at a